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$T = t + t_1 = \sqrt{\frac{r}{g}} \left(\frac{1}{6} \pi + 2\sqrt{2} - \sqrt{3} + 2 \log \frac{2 + \sqrt{2}}{1 + \sqrt{3}} \right) = 1666.673$ seconds = 27 minutes, 46.673 seconds.

$v_3 = 44869.668$ feet per second = 8.498 miles = $8\frac{1}{2}$ miles per second, nearly.

When $v_1 = r\sqrt{(2g/a)}$, $v_2 = \sqrt{(2gr)}$, and the velocity of arriving at the surface is independent of a , the distance from the center.

NUMBER THEORY AND DIOPHANTINE ANALYSIS.

163. Proposed by PROFESSOR R. D. CARMICHAEL, Anniston, Ala.

Prove that the equation $y^n = mx + 1$ always has at least one positive integer solution (different from $y=1, x=0$), whatever integer values m and n may have.

Solution by S. LEFSEHETZ, Pittsburg, Pa.

The following solution is evident:

$$y = (m+1)^n, \quad x = \frac{(m+1)^n - 1}{m}.$$

To find all solutions, we remark that it is enough to find all values of y such that $y^n \equiv 1 \pmod{m}$. Let f be a divisor of $\phi(m)$, a number to which f appertains. Then $a^f \equiv 1 \pmod{m}$. If also $a^n \equiv 1 \pmod{m}$, we must have $n \equiv 0 \pmod{f}$. Hence, f is a divisor of $dv[n, \phi(m)]$. Therefore we take the $\phi(m)$ numbers smaller than m and prime to it, we form the exponents to which they appertain and keep them if their exponents divide $dv[n, \phi(m)]$. If x be such a value, $y = x + km$ is a solution, the corresponding value of x being $\frac{y^n - 1}{m}$, which is integral since $y^n \equiv 1 \pmod{m}$.

AVERAGE AND PROBABILITY.

200. Proposed by PROFESSOR R. D. CARMICHAEL, Anniston, Ala.

A line $AB = l$ is extended to P making $BP = p$. If a point D is taken at random in BP , what is the mean value of $AD \cdot DP$?

Solution by J. EDWARD SANDERS, Weather Bureau, Chicago, Ill.

Let $x = BD$. Then $AD = l + x$, $DP = p - x$, and $AD \cdot DP = (l + x)(p - x)$.

$$\begin{aligned} \therefore M &= \int_0^p (l + x)(p - x) dx / \int_0^p dx = \frac{1}{p} \int_0^p [lp + (p - l)x - x^2] dx \\ &= \frac{1}{6}p(3l + p). \end{aligned}$$

Also solved by G. B. M. Zerr.